RESPONSE CORRIDORS FOR THE HUMAN LEG IN 3-POINT LATERAL BENDING

J. Kerrigan[a], K. Bhalla[a], N.J. Madeley[a], J. Crandall[a], and B. Deng[b]

[a]Center for Applied Biomechanics
University of Virginia
Charlottesville, Virginia, 22903
kavi@virginia.edu

[b]Vehicle Development Research Laboratory
GM Research & Development Center
30500 Mound Road, Warren, MI 48090
bing.deng@gm.com

Leg fractures resulting from bumper loading are among the most common lower limb injuries sustained in vehicle-pedestrian crashes. Thus, the development of validated computational models of the leg is important for the design of pedestrian safety vehicle countermeasures. In this study, 10 lateral-medial 3-point bend tests are performed on cadaveric leg specimens and results are scaled to match the anthropometry of a 50^{th}% adult male.

Unembalmed, flesh-on, tibia-fibula complexes were disarticulated at the knee and ankle and potted on roller supports (Figure 1). Strain gages and acoustic failure sensors were mounted on the bones, angular velocity sensors were used to monitor the potting cup rotation, and support load cells were used to measure forces. Six quasi-static and 4 dynamic (1.6 m/s) 3-point lateral bend tests were performed using a servo-hydraulic test machine.

Since in 3-point bending, the dimensions of the specimen play an important role in the bending stiffness, the test results need to be scaled before they can be compared to the response of a 50^{th}% adult male leg. By performing dimensional analysis, scaling factors for force, λ_{force}, momentum, λ_{moment}, and displacement, λ_{Ldisp}, are derived from a mass scaling factor, λ_{mass}, and a length scaling factor, λ_L. An equivalent length scaling factor, is first computed, $\lambda_{Lequiv} = (\lambda_{mass}.\lambda_L)^{¼}$. From this the following scaling factors are derived: $\lambda_{force}=(\lambda_{Lequiv})^2$; $\lambda_{moment}=(\lambda_{Lequiv})^3$; and $\lambda_{disp} = \lambda_{Lequiv}$.

In order to compute response corridors, the stiffness curves are first normalized by their failure loads and displacements. The means and standard deviations of these curves are computed. Finally these normalized statistical corridors are scaled up by the mean failure loads and displacements to obtain response corridors for leg bending.

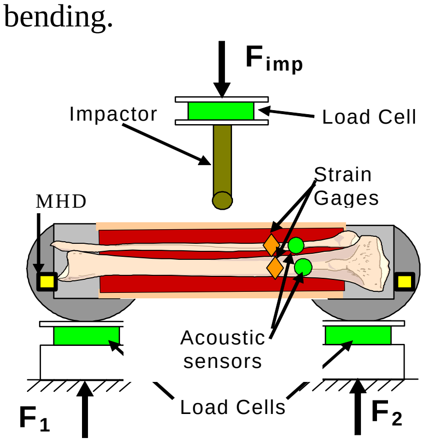

Figure 1: Leg bend test set up

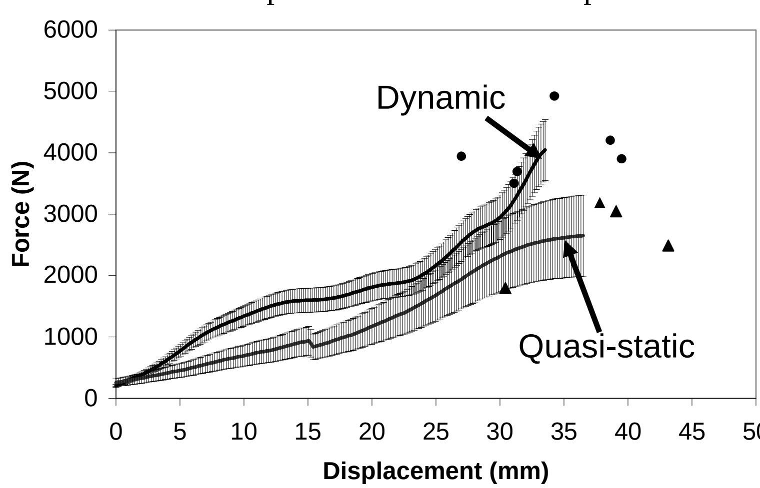

Figure 2: Scaled leg bend stiffness corridors (triangles show failure levels for quasi-static tests; circles for dynamic tests)